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Architectural Possibilities of Concrete Blocks

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ARCHITECTURAL POSSIBILITIES
OF
CONCRETE BLOCKS

BY

ERWIN MOSES LURIE

THESIS

FOR THE

DEGREE OF BACHELOR OF SCIENCE

IN

CIVIL ENGINEERING

COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS

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May 25, 1914.

I hereby recommend that the thesis prepared under my direction by ERWIN MOSES LURIE entitled ARCHITECTURAL POSSIBILITIES OF CONCRETE BLOCKS be accepted as fulfilling this part of the requirements for the Degree of Bachelor of Science in Civil Engineering.

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ARCHITECTURAL POSSIBILITIES OF CONCRETE BLOCKS.

Introduction.

The concrete block industry is still in its infancy. The use of blocks in place of other building material, has been brought to the attention of architects and builders, only within the past dozen years or so. Hence the fact that blocks are not more extensively used is not entirely without reason, because the architect is very careful and hesitant when called on to recommend new and untried building materials. His reputation depends on the character of the structures he designs; he believes in having the other man do the experimenting It was just such experimenting (exploiting would perhaps be more appropriate) by the manufacturers of concrete blocks, which brought them into disfavor with the men whom the manufacturers should have tried to please. Coming in on the high tide of favor caused by the extensive advertising of cement and concrete, advocates of concrete blocks forgot everything but the desire for financial returns. Thousands of blocks containing a minimum of cement were made without regard to durability or strength; and practically all were made with that dullness and sameness of appearance which was displeasing to the eye of everyone having the slightest conception of the artistic. Furthermore, the so-called rock-face blocks were imitations of stone, and this was quite sufficient to cause them to lose caste with reputable builders and architects. Consequently for the past few years concrete blocks have been trying to live down their past in order to acquire

the prestige which should rightfully be theirs.

The present status of building operations makes the use of concrete blocks advantageous for two reasons. In the first place, it must be remembered that the increasing price of lumber is such that not uncommonly the difference in cost between a building of wood and one of a more substantial and fire-resisting material, such as brick or concrete, is so small that for the sake of economy in up-keep the latter type is built. In the second place, the huge annual fire loss of several hundred millions of dollars of property and thousands of human lives, on account of inflammable building materials, has brought squarely up to the people the necessity for using fire-resisting materials. Therefore as concrete blocks can be economically substituted for wood, and as concrete is not surpassed as a fire-resisting material, it would seem that if the inartistic appearance of blocks were improved, they should come to take an important place among the building materials.

Originally, it was intended to discuss concrete blocks with reference to their architectural, structural, and economic qualities; but the limitations on the writer's time have made it necessary to narrow the scope of his thesis. Therefore, for the present, he will confine himself to the first named of these divisions, the architectural, with the hope of writing upon the other phases of the subject at some future time.

ARCHITECTURAL POSSIBILITIES OF CONCRETE BLOCKS.

A logical discussion of the architectural possibilities of concrete blocks should include the consideration of (1) the surface treatment of individual blocks, and (2) the architectural treatment of block structures. These subjects will be developed and treated in the following order:-

(1) Esthetic treatment of blocks.

(2) Concrete blocks for stucco work.

(3) Concrete blocks for base-courses and trimming.

(4) Concrete-block buildings.

CHAPTER I. ESTHETIC TREATMENT OF BLOCKS.

IMPORTANCE OF APPEARANCE. Cheapness was the basis on which many concrete block manufacturers tried to establish a market for their product. For a time, when blocks were used only on cheap and unpretentious buildings, all went well; but when it was found that more costly and monumental structures might well be constructed of blocks, an almost insurmountable obstacle was encountered, since architects both individually and collectively, would have nothing to do with concrete blocks. They did not choose to consider the blocks as a possible structural material for the buildings they designed; and their reasons for doing so were entirely valid,- the blocks lacked individuality and life.

Ninety per cent of all concrete blocks presented an exterior which was supposedly an imitation of cut stone. Manufacturers of blocks advertised their product as resembling natural stone so nearly that the difference could not be detected except on close inspection. To overcome the objections to the earlier and cruder imitations of stone, the fit contemporaries of the sheet-iron-stone store fronts, some manufacturers of concrete-block machinery used blocks of natural stone as patterns for the face-plates of their molds. Nevertheless, comparatively little was gained by this, for block manufacturers having only one or two face-plate patterns against which to mold their blocks, perforce made them with exactly similar surfaces. Hence their typical, lifeless, dull, gray appearance was accentuated in large expanses of wall, by monotonous similarities in light and shade. When it is remembered that architects study the effect of light and shade,

and color and texture of the exposed faces of walls quite as much as they plan the main architectural features of their structures, and that individuality is the goal of the architect, and that brazen imitation is certain to jar his artistic temperament, it is conceded that the coolness of the profession toward concrete blocks is not unreasonable. That this view-point is appreciated by some manufacturers of concrete-block machinery is shown by the fact that when, after noting the absence of the usual display of rock-pattern face-plates, the author asked a manufacturer why he did not make them, he was told:

"We do, but we put them out of sight as we prefer not to sell them."

APPEARANCE OF BLOCKS. The appearance of concrete blocks is dependent in great part on the consistency of the mixture used in their manufacture, and on the character of the surface finish. On account of improvements in its appearance, the building block has slowly found its way into the good will of many architects. These improvements have been brought about in two ways, viz.: (1) by substituting a wet for a dry mixture; and (2) by introducing artistic surface finishes.

ART. I. CONSISTENCY.

DRY-MIXED vs. WET-MIXED BLOCKS. The three general classes of consistency ordinarily employed are defined as follows:

(1) Damp consistency, water constitutes about 9.5% of total weight dry materials. Amount of water such that when a small quantity of mortar is pressed and rolled in the hand it will form a ball and show no excess of moisture.

(2) Wet consistency, water about 13.5% of total dry materials. Amount of water such that light troweling will bring water to surface of pat.

(3) Sloppy consistency, water about 18.5% of total weight of dry materials. This contains enough water so that the mass can be poured from a bucket.

One of the worst features of dry-mixed blocks (consistency about 8%) is their great thirst for water after being built into the wall. Nothing detracts from the good looks of a building so much as a blotchy appearance due to the varying absorptive powers of the different blocks. This has been one of the most flagrant faults of concrete blocks. The additional water necessary for complete crystallization of the cement does not permit of the rapid withdrawal of the cores, because the green block is likely to warp out of shape. (This applies to side-drawn cores only.) Hence to produce the same number of blocks using a wet mix instead of a dry one, more time and more machinery is required. This is a disadvantage and one to which pioneer block manufacturers were not inclined to submit. Consequently many buildings have been erected, and a few are still being built, of dry-mix blocks. Such blocks are said to be "made against time". It may not be altogether surprising to know that in some cases after sprinkling the new front lawn, the builder turns the hose on the handsome new concrete-block front itself, in order to provide water to crystallize the cement. Owners are frequently put to the expense of applying a surface coating in order to make the blocks damp-proof, for it is claimed that it takes such blocks from three to twelve years to become absolutely water tight through the clogging of the surface of the block by rain-

deposited atmospheric dust.* However, most of the difficulty formerly experienced in withdrawing the cores from the mold has been eliminated by changing the manipulation of the machinery so that the cores are withdrawn vertically; and hence the thin web walls are left in a vertical position, and are not so apt to collapse.

RELATION OF CONSISTENCY TO TYPE OF MOLDING MACHINE. At this point it may be well to consider the relation of the type of the molding machine to the amount of water used. In a great majority of molding machines the same face-plate is used for every block, and therefore it is necessary that the amount of water be limited so that the block will part readily from the plate. An excessive amount of water will cause the facing to stick when the block is stripped. In such machines, however, if no cores are used, the body of the block may be made quite wet, the deciding factor being the ability of the block to retain its shape while hardening. In using cores, the consistency permissible is dependent, as has already been suggested, on the position of the block when the cores are withdrawn, a rather wet mixture being permissible with the vertical-draw machines and a dryer mixture being necessary with the horizontal-draw machines.

In machines in which individual face-plates are used, i.e., those in which the face-plate remains with the block until it is hard enough to be readily handled, the block is not stripped from the face-plate, and hence a very wet mixture may be used. This is a prominent feature in some hydraulic- and mechanical-pressure block machines which turn out solid blocks with plain faces, the face-plate being merely sheets of tin.

*Lewis' Handbook for Cement and Concrete Users, page 346.

RELATION OF STRENGTH TO CONSISTENCY. Adaptability to the machine, however, is not the only factor which must be considered in determining the consistency of the mixture. The strength of concrete depends greatly on the amount of water used in mixing. Formerly it was the custom to mix concrete as dry as possible, since experience showed that concrete made in this way would become hard much sooner than when an excess of water was used. Table I shows results of experiments made at three American universities to determine requirements for standard laboratory and field tests of concrete in compression.

TABLE I

STRENGTH OF 6-INCH 1:2:4 CONCRETE CYLINDERS OF VARIOUS CONSISTENCIES AT DIFFERENT AGES.*

Average Compressive Strength in Pounds per Square Inch.

Age	PLACE OF MANUFACTURE OF SPECIMENS.								
	Univ. of Ill.			Univ. of Wis.			Mass. Inst. Tech.		
	Dry	Normal	Wet	Dry	Normal	Wet	Dry	Normal	Wet
7 day	1751	1390	1103	1690	1580	533	2047	1740	965
14 "	2140	1775	1354	2795	1905	600	2742	2320	1472
21 "	2658	1816	1623	2450	2095	722	2594	2396	1464
28 "	2615	1820	1657	2380	2430	860	2679	2882	1895
2 mo.	3056	3063	2410	2485	2340	787	2761	3092	1830
6 "	3941	3431	3281	3375	3860	1451	....	....	....

Dry, percentage of water 8.4
Normal, " " " 9.3
Wet, " " " 10.2

*Report to the American Concrete Institute of the Committee on Specifications and Methods of Tests for Concrete Materials, Engineering Record, March 7, 1914, Vol. 69, No. 10.

In comparing the results for different ages, it will be well to remember that the standard specifications for the manufacture of concrete blocks (part of a report of a Committee of National Concrete Machinery Manufacturers' Association) state that "blocks should never be removed from the yard for the purpose of using in a building until they are from thirty to sixty days old." Hence in making comparisons of the data in the preceding table results for blocks less than 28 days old should be omitted. Table II, shows the relative strength of blocks 28 days and 2 months old.

TABLE II

COMPARATIVE STRENGTHS OF 6-INCH 1:2:4 CONCRETE CYLINDERS OF VARIOUS CONSISTENCIES AT DIFFERENT AGES.

Age	Average Compressive Strength pounds per square inch			Ratio Strength of Wet to	
	Dry	Normal	Wet	Dry	Normal
28 day	2558	2377	1137	44.5%	48.0%
2 mo.	2767	2832	1676	60.6%	59.2%

It will be seen that, although with increasing age the strength of the wet-mixed concrete tends to approach that of the dry- and normal-mixed, at the time the blocks are ready to be used there is a wide discrepancy in the relative strength of the three mixes, a difference which must be seriously considered. Further, it should be noted that this variation is caused by a difference of only 0.9 per cent in the amount of water, which shows the necessity for very accurate measurement of the quantity of water.

In comparing the strength of mortars made of a working consistency, i.e., a consistency used in actual work, with those of the same mortars made of normal consistency, the results reported by Mr. W. B. Reinke to the American Society of Testing Materials and shown in Table III will be found illuminating.

TABLE III.

TENSILE STRENGTH FOR DIFFERENT CONSISTENCIES. *

Normal Consistency

(Consistency as prescribed by specifications of the American Society of Testing Materials.)

Kind of Sand:	Ottawa	Ordinary Sands					
Per Cent of Water:	9.2	12	12-13	13-14	14-15	15-16	over 16
Number of Tests:	100	18	30	16	12	8	16
Average Tensile Strength in Pounds per Square Inch							
72 hours	192	200	105	80	52	43	43
7 days	301	273	258	215	170	158	129
28 days	410	388	377	325	262	251	187

Working Consistency.

(Consistency as used in actual construction, and containing about 50 per cent more water than normal consistency, depending on the sand used.)

Per Cent of Water:	13.8	17-18	18-19	19-20	20-21	21-22	over 23
Number of Tests:	64	8	6	12	10	8	10
72 hours	140	92	86	63	55	30	18
7 days	235	208	180	146	128	122	92
28 days	316	310	279	267	229	220	173

The data in the second column show the results obtained with standard Ottawa sand, while the data in the remainder of the

* Engineering and Contracting, July 16, 1913, Vol. 40, No.3.

table show results obtained with more than six different ordinary sands, each of which was mixed to a consistency similar to that of the Ottawa sand, but each of which required a different and greater per cent of water.

These experiments show that with the same cement and the same sand, at the end of 28 days the specimens made with a working consistency have on the average 80 per cent of the tensile strength of the specimens of the same age having a normal consistency. Furthermore, the above table illustrates the great decrease in strength with an increase in the amount of water necessary to produce normal consistency in mortars made with various sands. The variation in the amount of water required is due to a difference in the granulometric grading, the sands requiring the most water having the greater amount of fine material and hence having more surface to be covered and also a larger percentage of voids. The larger proportion of unfilled voids will, of course, decrease the strength. This brings in the subject of granulometric analysis which is hardly within the scope of this thesis. However, it is very evident that such an analysis should always be made. The conclusions reached by this experimenter (Mr. Reinke) are as follows:

"(1) The less water required to produce a mortar of given consistency, the higher will be the strength developed by the sand.

"(2) The coarser the sand, other things being equal, the greater will be the strength developed.

"(3) The higher the silica content, other things being equal, the greater will be the strength developed."

The general conclusions arrived at after a consideration of the results in Tables I, II and III, besides many other tables, are as follows: In blocks cured in water or water and air:-

The normal consistency of the mortar to be used in the manufacture of blocks should be determined. The amount of water which may be used in blocks to be handled within 28 days should not exceed that used in the normal consistency previously determined, by more than 0.5 per cent of the weight of the sand and the cement. In blocks not to be used until 60 days after manufacture, the amount of water may exceed that used in normal consistency by 1.0 per cent.

STEAM-CURING AND ITS RELATION TO CONSISTENCY. Within the past few years the discovery of the hardening properties of steam has revolutionized the concrete-block industry and incidentally has settled, for large manufacturers, the difficult problem of the consistency. Extensive tests have shown that blocks cured in steam for three days have attained the same compressive strength as blocks cured in air for 28 days. Hence the block-maker need not be hurried into making a dry-mixed quickly-handled block, because a hard wet-mixed steam-cured block may be turned out ready for use on short notice. A steam-curing equipment may be easily and cheaply installed, and reports show that in plants of large magnitude it is used almost invariably.

To illustrate the marked increase in strength due to steam-curing as compared with air-curing, Table IV is appended to show results of tests made at the University of Illinois by

Messrs. J. R. Montigel and L. O. Stocker.* The test specimens were thin-web tile of a 1:4 mix, having a cross-sectional area of 36 square inches and a net volume of concrete of 216 cubic inches. The tests were made to determine the effect of changes in consistency and duration of curing.

*Bachelors' Thesis, 1912, University of Illinois Library.

TABLE IV.

COMPRESSIVE STRENGTH OF 1:4 HOLLOW CONCRETE BLOCKS.

Batch No. *	Average Weight, pounds	Age When Tested, days	Cured in Steam, hours	Cured in Air, days	Ult.Str., pounds per sq.in.	Gain over Air-Cured Specimen of Same Age, per cent.
Damp Consistency+ -9.7% water. Set in Air 24 hours at 76° F. Air Curing at 76°F. Steam Curing at 210° F.						
A4	134	7	0	6	583	00.0
A1	135	"	24	5	668	14.6
A2	136	"	48	4	950	63.0
A3	136	"	72	3	920	58.0
B4	135	28	0	-	1022	00.0
B1	136	"	24	-	1172	14.7
B2	137	"	48	-	1165	14.0
B3	138	"	72	-	1423	39.3
Wet Consistency - 13.5% water. Initial Set in Air 2 hours at 76°F. Initial Set in Steam 12 hours at 140° F. Steam Curing at 210° F.						
C'3	138	7	0	7	1003	00.0
C'1	139	"	48	5	1075	7.3
C'2	141	"	72	4	1172	16.8
D3	143	28	0	-	1532	00.0
D1	143	"	48	-	1830	19.4
D2	145	"	72	-	1867	21.8

*Each batch consists, in general, of three specimens.

+Consistencies as defined on page 5.

A comparison of the results obtained in these experiments brings to light some interesting facts. In the first place, although B4 (28 day air) shows an increase over A4 (7 day air) of 75 per cent, it is only 7.3 per cent stronger than A2 (48 hours steam). This illustrates the relative efficiency of air- and steam-curing. Again, B2, steam-cured 48 hours, and 28 days old, is 70 per cent stronger than A2, of the same curing but 7 days old; while the specimens of these two ages cured 72 hours show an increase of 59.4 per cent for the older one. The wet mixed specimens do not show such a large increase in strength for the steam-cured as compared with the air-cured; and probably because of additional tamping received while molding, D3, 28-day air-cured, is 30.6 per cent stronger than C'2, steam-cured 72 hours but only 7 days old. In contrast with results obtained by most experimenters, the 7-day wet-mix specimens were 27.5 per cent stronger than the corresponding damp-mix specimens; and the 28-day wet-mix specimens were 31.2 per cent stronger than the corresponding dry-mix specimens. This is no doubt explained by the fact that the wet-mix specimens were given an initial set in steam at low temperatures, and suggests a valuable yet inexpensive way of securing early hardening without resorting to high-temperature steam.

Steam-cured blocks are superior to air-cured blocks because they are not only stronger but also less porous than the latter.

When making tests for the compressive strength of tile, Messrs. Montigel and Stocker also made porosity tests. Table V shows the results obtained.

TABLE V.

POROSITY OF 1:4 CONCRETE TILE.

Batch No. *	Age when tested days	Initial Set in	Cured in	Hours of Steam Curing	Consistency of Mortar.X	Absorption by Volume. #
A4	7	Air	Air	0	Damp	22.4%
A1	"	"	Steam	24	"	21.0
A2	"	"	"	48	"	19.2
A3	"	"	"	72	"	19.7
B4	28	"	Air	0	"	20.8%
B1	"	"	Steam	24	"	15.75
B2	"	"	"	48	"	14.1
B3	"	"	"	72	"	11.1
C'3	7	Air	Air	0	Wet	15.75%
C'1	"	Steam	Steam	48	"	15.5
C'2	"	"	"	72	"	14.7
D3	28	Air	Air	0	"	9.85%
D1	"	Steam	Steam	48	"	8.95
D2	"	"	"	72	"	7.3
E3	7	Air	Air		Sloppy	4.72%
E1	"	Steam	Steam		"	4.2
E2	"	Steam	Steam		"	1.92
F3	28	Air	Air		"	3.63%
F1	"	Steam	Steam		"	3.45
F2	"	Steam	Steam		"	4.2

* Each batch consists, in general, of three specimens.
X For definitions, see page 5.
Of dry specimen.

The results in Table V justify the following conclusions concerning porosity: (1) porosity decreases directly with increase in duration of steam-curing; (2) porosity decreases with increase in amount of water used in mixing; and (3) porosity decreases with age. Tables IV and V warrant the following conclusions concerning the consistency of mix when steam-curing is used: With a steam-cure of at least 48 hours, the water used in mixing the concrete may be of an amount not to exceed 3/2 of that used with that particular cement and sand to form a mortar of normal consistency.

Having discussed the relationship to the consistency of mix, of type of molding machine, strength, porosity, and steam-curing, one more point illustrating the advantage of using the wet mix will be mentioned, and then the general conclusions concerning the wet-mixed and the dry-mixed blocks will be stated.

The wet mixture is preferable to the dry because the crumbling and rounding of the corners of blocks on account of weathering and handling, is reduced to a minimum. The writer has examined a considerable number of blocks made by various processes, and was struck by the fact that corners on blocks several years old could be rubbed off with the hand. From the appearance of the blocks it was evident that the cement was skimped and the blocks were mixed dry. On the other hand, blocks made with a medium wet 1:2:4 mixture for the body and a facing of the mix and consistency used in the top coat on cement sidewalks, have weathered for a number of years and appear as good as new.

WET-MIXED vs. DRY-MIXED BLOCKS. Wet-mixed blocks are better than dry-mixed blocks because they are less porous, and

hence less absorptive, and therefore are more sanitary and less liable to discoloration on account of dust in the atmosphere. By the use of steam-curing in place of air- and water-curing, wet mixtures immediately attain the same strength as dry ones of the same age. Again, wet mixtures produce more uniform and reliable blocks than dry mixtures. Finally, the crumbling and rounding of corners due to weathering and handling is eliminated.

ART. 2. SURFACE FINISH.

A means of drawing the attention of architects and builders toward the use of concrete blocks as a building material, even more effective than the substitution of a wet for a dry consistency, has been the great developments in the variety and the character of surface finish. In the successful blocks of to-day, the lifeless exteriors acquired in the wood or metal mold have been done away with by a great variety of means. These will be described in the following paragraphs. See Fig. 1 - 7.

Surface finishes are of two general classes: (1) those in which the finish is imparted during the molding process, and (2) those in which the face is treated after the blocks are removed from the mold. Further variety in the appearance of the blocks made by either method may be secured by the use of: (1) different kinds of face-plates; (2) various consistencies of mixture; (3) various proportions of cement and aggregate for the facing material; (4) coloring pigment; (5) cement and aggregate of various colors; (6) mechanical processes in finishing; and (7) surface coatings. These different methods will be treated in the order given.

1. USE OF DIFFERENT KINDS OF FACE-PLATES. The most serious objection to concrete-blocks as made at the start of the industry, was their monotonous appearance. "No matter which way the eye is cast along a wall built with but one design of rock-faced blocks there is a sameness, right or left, up or down, or crosswise, always that awful monotony." The first effort to relieve blocks of this fatal monotony was by the agency of different face-plate patterns. To substantiate the claim that blocks could be made to look like cut-stone, it was necessary that not only individual blocks, but the whole wall should present an appearance like cut-stone. By turning a block up-side down, providing it was not symmetrical, two varieties would be formed; but this afforded only a little variety, and hence various face-plates imitative of numerous kinds of natural stone were made. Some of the very recent developments in rock-face blocks are shown in Plate I. The ability to produce the most perfect imitations still seems to be a matter of much moment with many block-machinery manufacturers.

If at the start the panel- and plain-faced blocks had been as well advertised as the rock-faced blocks, the reaction against concrete blocks on account of their crude attempt to imitate stone, never would have set in, because it is possible to make plain- and panel-faced blocks "as durable and as beautiful as brick or stone, as logical as either of these units, and yet resembling neither." This brings us to the bitter controversy between architects and the advocates of rock-face blocks. This controversy has such a direct bearing on the entire concrete-block industry that it will be well to investigate the matter to some extent.

PLATE I - MOLDED SURFACE FINISHES

FIG. 1 ROCK FACE

FIG. 2 ROCK FACE

FIG. 3 ROCK FACE

FIG. 4 PLAIN AND ROCK FACE

FIG. 5 ROCK, TOOL MARGIN

FIG. 6 BUSH-HAMMERED, TOOL MARGIN

FIG. 7 CRUSHED GRANITE FACE

The following extract from the catalog of a large block-machinery manufacturing company brings to light the particular rock on which, many architects claim, the block industry has been wrecked: "With our new faces we have solved the problem for the builder using blocks, for by using these four designs erect and reversed he secures a variety of eight patterns which used promiscuously in building up a wall produce a result so natural that even the trained eye can not detect such construction from the prohibitively expensive rock-hewn work."

It is this attempt at imitation which has placed ignominy on all concrete blocks, whether they are in the same class with those above or not#; and the writer has as yet failed to see any rock-face blocks which could not be immediately distinguished as being an artificial product It does not seem as if the manufacturers give the public sufficient credit for discriminating taste. However before condemning the rock-face block-machinery manufacturer too severely, it might be well to state his point of view. Mr. Frank Zagelmeyer of Detroit says: " *** "Man is by nature an imitator. It is by imitation that he finally learns to excel, and the better he imitates the more successful he is. *** The basic principle of all art is founded on scientific imitation; and simply because some sculptor ** makes a bad imitation of his subject, the loyal supporters of the somewhat uncertain science of art do not blame art itself, but the artist. This is as it should be in concrete. Just because some block-makers put poor rock-face designs on their blocks is no reason for blaming that form of design. The maker should be blamed. ** Friends of the block industry, instead

of condemning the use of the rock-face design should encourage better rock-faces. As a manufacturer of cement blocks as well as of block molds ** my experience leads me to believe that ** at least ninety per cent of the purchasers of cement blocks will choose the rock-face design, if a large variety of well-made patterns can be had. ** One pattern used throughout a job ** is not imitation of rock-face stone; and it is this lack of imitation that has caused what little real objection there is to rock face design from the users of cement blocks. The users are the ones who pay for the blocks, and consequently are the only ones whom the manufacturers try to please. I do not wish to be understood to mean that the only future the cement block has is through the use of rock-face design. There are several other applications, some of them capable of being made very beautiful; but the rock-face has been from the start, and probably always will be, the favorite design for cement blocks." *

The writer can not agree with Mr. Zagelmeyer on a number of points. It is almost certain that the builder chooses the rock-faced block because he has never seen a structure built of any other kind of block; and as the appearance of the basement (for which the larger portion of the block output has been used) is of little moment to him, he chooses, as his neighbor has, the rock-faced block. In the second place, if it is this lack of imitation that has caused the <u>little</u> real objection to rock-face design from the USERS of cement blocks, what about the objection against any form of imitation raised by the countless thousands who are NOT

* Cement World, Vol. IV, No. 9, Dec. 1910.

USERS of blocks but who would be if they did not have to stifle their artistic sense for the sake of mere imitation. Finally, concerning the statement that "the users are the ones who pay for the blocks and consequently are the only ones whom the manufacturers try to please", the less said the better. Probably the writer of that article has had occasion to change his mind since the time he wrote it. This same narrow view on the part of almost all manufacturers of concrete-blocks has been the greatest barrier in the march of the concrete-block toward popularity. But all signs point to the adoption of a broader view on the part of the manufacturer, and we may expect great developments in the future of the block.

To eliminate the similarity of light and shade on rock-face blocks, Mr. Zagelmeyer proceeds as follows: "Twenty different plates are used to produce the rock-face blocks, and the blocks are manufactured in continuous variety. Each car of blocks *** as piled in the yard contains twenty different patterns so that in making a shipment of blocks from the yard,*** there is always the same variety of rock-face design, and practically the same number of each variety in each shipment. The designs being thus mixed from the time they are manufactured to the time they are shipped ** makes it possible to continue the variety in putting the blocks in the wall. The result is an absence of sameness in adjacent blocks."*

This method is quite ingenious and marks the highest point in the development of the manufacture of rock-face blocks. From a business standpoint it appears to be successful. Any combinations of patterns of rock-face blocks will produce somewhat the

* Concrete-Cement Age, Vol. 4, No. 2.

same effect as the preceding, namely, variation as between adjacent blocks, and differences in lights and shadows along the wall; but the final result will be an imitation stone-wall. Moreover rock-face blocks, unlike other substantial building materials, do not convey the impression of massiveness and solidity. The blocks are understood to be hollow, and forthwith are condemned as unsubstantial by many "self-educated" laymen whose past experience teaches them that hollow bodies are of necessity not as strong as solid ones. In contrast, plain- or panel-faced blocks present a surface which does not easily suggest hollowness, and hence the notion of unstableness is not readily conceived. Finally, concrete is a distinctive type of material and has a distinctive appearance which is fully as meritorious as stone. Concrete is manifestly a poured or synthetic material, so what harm in making it look the part. The plain- and panel-faced blocks are the logical units in which to portray this feature of concrete, and besides they embody all the good features of rock-face blocks and none of the bad ones.

2. USE OF MIXTURES OF VARIOUS CONSISTENCIES. The marked effect on the strength and the porosity of blocks by the use of various consistencies of mixture has already been considered in Art. I. Differences in consistency also have considerable effect on the ultimate appearance of the blocks. A dry mixture, other conditions such as tamping, etc., being the same, will give a block a coarser and more pock-like surface than can be obtained by the use of a wet mixture, because the larger aggregate will prevent the cement and finer particles from flushing to the surface. With a very wet mixture, using ordinary hand-tamping and a block

molded face-up, the finer particles, called laitance, in the concrete will rise and form the exposed face of the block. Such a process will give the block a dense surface which, because of its impermeability, is desirable. Nevertheless, upon personal inquiry, and close investigation of many blocks, the author has found that such surfaces are much more apt to check and hair-crack than rougher surfaces. Many walls, especially those of smooth stucco or monolithic concrete, while presenting an excellent appearance at a distance are, on account of web-like hair-cracks, a disappointment at close range. Hair-cracks are almost certain to occur if the finely divided cement is allowed to remain on the surface, because this skin of fine material has only little strength and will not expand and contract at the same rate as the body of the block. Hence care must be exercised to see that the surface presented to the elements is without the powdery laitance; and therefore a slightly dryer mix is preferable.

3. USE OF VARIOUS PROPORTIONS OF CEMENT AND AGGREGATE. Tests of hollow blocks made at the Watertown Arsenal and in the Pennsylvania Rail-Road Shops show that 8" x 8" x 16" ordinary 1:4 blocks have a compressive strength ranging from 30 to 100 tons per block, equivalent to 33- 1/2 tons per square foot gross area. This is much in excess of that needed in ordinary buildings, and hence it is permissible to reduce the amount of cement and introduce a larger proportion of the coarse aggregate. If a comparatively lean mixture of crushed stone and cement, say 1 part cement, 1 1/2 parts sand, and 4 1/2 parts crushed limestone screenings which will pass a 1/2-inch mesh and be retained on a 1/4-inch mesh,

be used for the facing, a very rich and pleasing surface will result. In this case the facing would not contain the full amount of finer aggregate which is necessary in the body of the block to thoroughly fill the voids and thus give the block the required compressive strength. Such a mixture was used for the facing of the Administration Building of the South Park Board of the City of Chicago. This exterior has been the source of much favorable comment, which it well deserves, since it exhibits a truly distinctive surface unique to cement products. The fact that this and similar surfaces have stood for several years without injury from frost sets aside the contention that rough concrete surfaces would not weather well with changing atmospheric conditions. An effect similar to that produced on the Administration Building can be obtained by using almost any coarse aggregate and removing the surface cement by scrubbing or other means. This method will be described in detail in a subsequent article.

4. USE OF COLORING PIGMENT. The use of coloring pigment to produce variety in the appearance of concrete is mostly confined to monolithic work; but there seems to be no reason why it should not be successfully employed in coloring concrete blocks. Coloring pigments are not used to a great extent for this purpose, probably because few men have had extensive experience with them, and because little experimental work seems to have been done to determine the relative lasting qualities of different kinds of pigment, and also because positive results in color variation can be obtained by the use of colored aggregate. This process will be described in the next article.

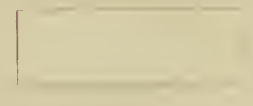
Only mineral pigment should be used, as the general consensus of opinion is that other material such as vegetable and animal oils and fats cause the colors to fade and the cement to disintegrate. Table VI shows proportions advocated by different authorities for use when mixing coloring pigments. See also Plate II.

As has already been said, the permanency of results obtained by the use of coloring pigments does not seem to be well established. One writer says: "The facts in the case show two things: first, that all colors produced by such artificial means are liable to fade with time; and second, that the use of such adulterants in quantity adequate to produce the required color with sufficient strength to prevent fading for a reasonable length of time, weakens the concrete."

5. USE OF CEMENT AND AGGREGATE OF VARIOUS COLORS. The most satisfactory concrete surface of a given color and texture is obtained by using a facing mixture composed of cement and an aggregate of the proper size and color. If the facing material be thoroughly bonded to the body of the block, it is not essential that the block be made of the same mixture throughout. Hence more expensive aggregate such as marble chips, crushed granite, etc., can be economically substituted for the ordinary limestone or gravel in the facing, as the latter need be only 1 2 to 1 1/2 inches thick (depending on the molding process used).

Fig. 8 to 13 taken from the Universal Portland Cement Company's bulletin on "Concrete Surfaces" show the beautiful colors which may be secured by the use of different colored aggregates. In these cases Portland cement was used with the following aggregate: (See Plate III).

PLATE II COLORING PIGMENTS



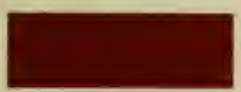
WHITE

BUFF

PALE GREEN

TERRA COTTA

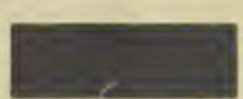
OLIVE GREEN



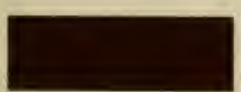
RED

BLUE

LIGHT BROWN



GRAY



DARK BROWN

BLACK

Authorit
Ass'n Portland Cement Manf'rs. (London 1909
H.G.Richs
W.G.Hayne
G.W.Steve x
Symposium of Britis Concrete Institute 1913. ¢
*Common Veneti x 'Best

TABLE VI. PROPORTIONS TO BE USED WITH COLORING PIGMENTS.

Authority	Color							
	Black	White	Red	Yellow	Blue	Green	Brown	Buff
Ass'n Portland Cement Manf'rs. (London) 1909	87% cem. 13% black oxide of manganese or any other carbon black	67% cem. 33% powdered chalk or sulfate of barytes	87% cem. 11% red oxide of iron 2% black oxide of iron or copper	84% cem. 14% yellow oxide of iron 2% black oxide of iron or copper	80% cem. 18% azure blue or ultramarine 2% black oxide of iron or manganese	85% cem. 12% Chrom. oxide 3% black oxide of iron or manganese		
H.G.Richey	1 bbl.cem.to 45 lb. of manganese-dioxide *		1 bbl.cem.to 22 lb. raw iron oxide*	1 bbl.cem.to 22 lb.yellow ochre.	1 bbl.cem. to 19 lb.ultra-marine	1 bbl.cem.to 23 lb.green-ish blue ultramarine	1 bbl.cem.to 25 lb. best roasted iron-oxide,or to 15 to 20.lb. of brown ochre	1 bbl.cem. to 15 lb. yellow ochre #
W.G.Hayne	1 cu.ft.cem. 2 " " sand 3 lb. Excel-sior carbon lamp black		1 cu.ft.cem. 2 " " sand 5 lb. raw violet oxide of iron.		1 cu.ft.cem. 2 " " sand 4 lb.ultra-marine blue.		1 cu.ft.cem. 2 " " sand 4 lb.brown ochre.	
G.W.Stevens x			1 bbl.sand to 10 lb.violet oxide of iron.		1 bbl.sand to 3 1/2 lb.of ultramarine blue.(For dark blue add 1 lb. Germanto n lamp black.		1 bbl.sand to 6 lb.brown ochre	1 bbl.sand to 5 to 7 lb.yellow ochre.
Symposium of British Concrete Institute 1913. ¢	Black oxide of manganese best; not possible to obtain clear black. *	Clean white not obtain-able; near-est approach by use of slaked white	Red hematite (iron oxide) is best.	Use yellow ochres	No satisfact-ory pigment. Ultramarine is unsafe.		Use burnt umber.	

*Common lamp black, Venetian Red } should not be used as it is liable to run and fade.

x "Best to mix coloring with sand." Barrel is 3.8 cu.ft.

This proportion will greatly reduce strength of block.

¢ Color should be mixed with dry cement. Slaked lime should be mixed with cement and aggregate.

Fig. 8. 1/4-inch yellow marble screenings from which the material passing a No. 8 sieve had been removed.

Fig. 9. Aggregate same size as above, but red granite was used in place of the yellow marble.

Fig.10. 1/8-inch to 1/2-inch black marble.

Fig.11. 1/4-inch to 1/2-inch lake shore gravel.

Fig.12. 1/4-inch black and white marble and red granite.

Fig.13. 1/8-inch black and white marble and red granite.

Thus marbles, granites, sandstones, gravels, burnt clays, corals and sands may be used in all manner of combination to produce color in endless variety.

The proportions used for the facing mixture are about as follows: 1 part Portland cement to 1 1/2 parts and and 2 1/2 parts crushed granite, marble, etc., which passed a 1/2-inch screen and was retained on a 1/4-inch screen. The mortar should not be too rich as it is then more apt to hair crack.

When blocks having a white surface are desired, limestone screenings are frequently used for the facing material. Blocks made of such screenings sometimes have hair-cracks, but it has not been decided whether the checking is due to the action of atmospheric gases or to poor workmanship. White sand does not always give the uniform results that might be expected, a blotchy effect sometimes being produced. Although good results have frequently followed the use of white cement, the author is not convinced that the white facing so produced is as stable as it should be. It is hoped that experiments will be made in the near future to determine the relative efficiency in white surfaces of white screenings, white sand, and white cement.

PLATE III COLORED AGGREGATES

FIG. 8 $\frac{1}{4}$-INCH YELLOW MARBLE

FIG. 9 $\frac{1}{4}$-INCH RED GRANITE

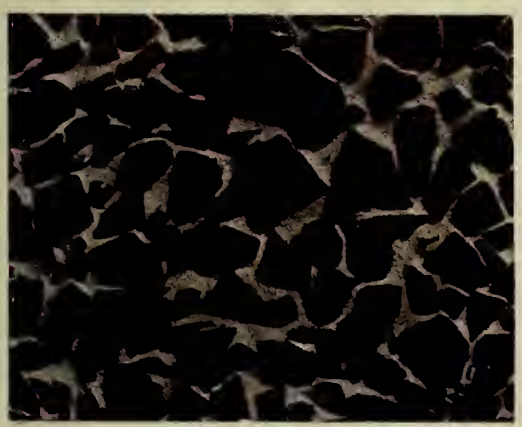


FIG. 10 $\frac{1}{8}$-$\frac{1}{2}$-INCH BLACK MARBLE

FIG. 11 $\frac{1}{4}$-$\frac{1}{2}$-INCH GRAVEL

FIG. 12 $\frac{1}{4}$-INCH BLACK AND WHITE MARBLE AND RED GRANITE

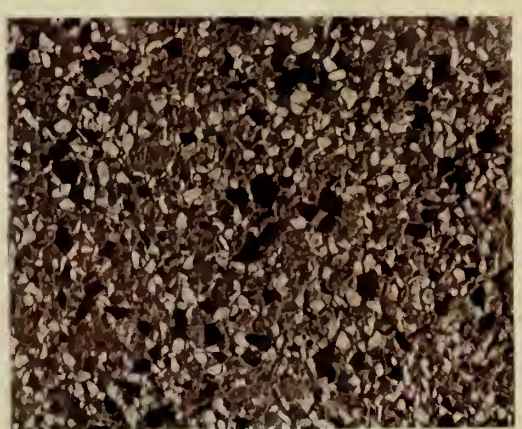


FIG. 13 $\frac{1}{8}$-INCH BLACK AND WHITE MARBLE AND RED GRANITE

The color of the different brands of ordinary Portland cement is so nearly the same, that no appreciable differentiation of color in the face of the block can be obtained by using different brands; but once adopted, the same brand should be used throughout the job.

Additional variety in color and texture can be obtained by varying the size of the colored aggregate, the smaller sizes yielding a fine-grained surface, the larger sizes producing a coarse grained surface. Compare Fig. 12 and 13.

Before leaving the subject of colored aggregates, it may be well to briefly mention the new (patented) process for applying granite faces to blocks used at the Zagelmeyer plant at Detroit. The face-plates are given a coating of glue, which while still soft is covered with granite chips. After the glue is set this facing is covered with a layer of neat cement, and the body of the block is then cast against the cement and granite facing. The steam-curing which the block undergoes, softens the glue, and it comes away with the face-plate leaving the resulting surface such that it requires no cleaning. Fig. 14 to 16 show the results obtained by this process.

In general, when using a facing mixture which is different from the mixture in the body of the block, either a face-up or a face-down machine is preferable to a side-face machine, because (1)better supervision can be exercised in placing the facing material; and (2) as the pressure is almost universally applied in a vertical direction, a better bond between the facing and the body can be secured. In wood molds used for special blocks, the facing

PLATE IV SURFACE FINISHES

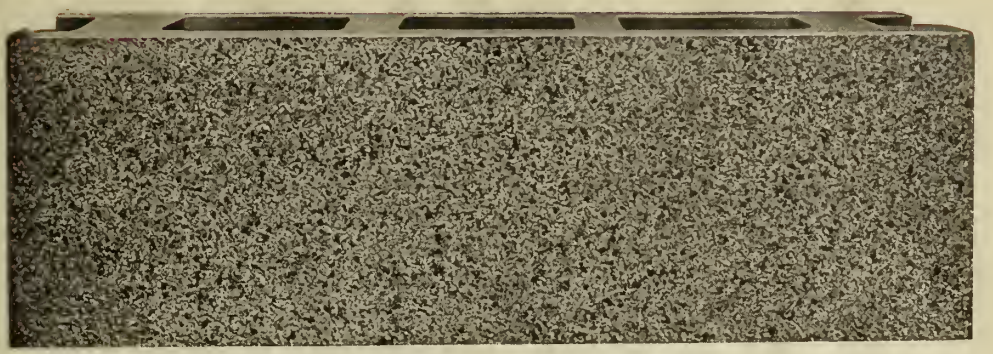


FIG. 14 ZAGELMEYER GRANITE FACING

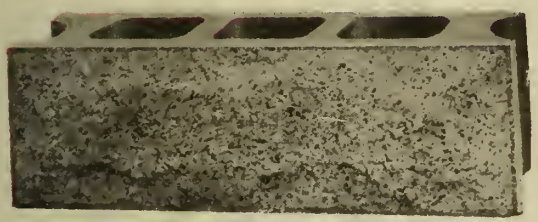


FIG. 15 (SAME AS FIG. 14)

FIG. 16 ENLARGEMENT OF NOS. 14 & 15

FIG. 17 TROWELING

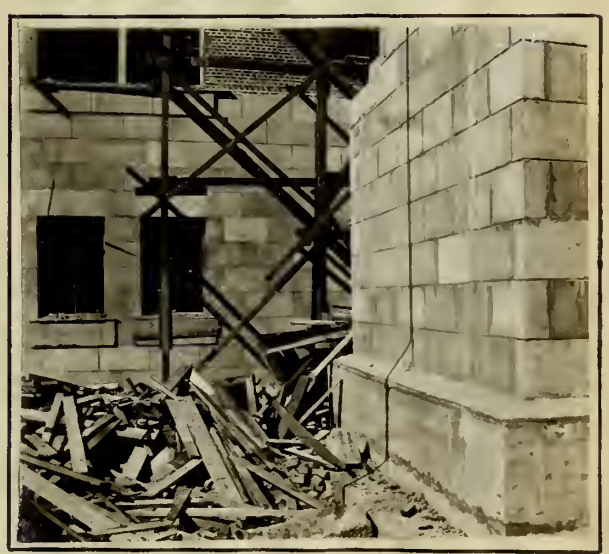


FIG. 18 TROWELED BLOCKS

can be plastered against the side of the mold just before placing the body material, or it may be placed by means of a separation plate which is then removed so that the two parts of the blocks can be tamped together. Finally it is well to remember that in obtaining the coloring by means of the aggregate, the strength of the block is in no way affected as is so apt to be the case when using pigments for coloring purposes.

6. USE OF MECHANICAL TREATMENT. Mechanical treatment is used for the purpose of securing variety in surface texture. The following are some of the mechanical processes used: A, troweling; B, scrubbing; C, rubbing; D, tooling; E, sand-blasting.

A. Troweling. An ordinary cement-finishers' trowel is used in troweling block surfaces, and the finish is put on in the same way as the finish on a cement sidewalk. (See Fig. 17). This process was used in making 15,000 solid hand-tamped plain-faced blocks cast in wood molds, the facing being composed of equal parts of Portland cement and limestone screenings which would pass a 1/8-inch screen. (Fig. 18) After troweling, a large brush was run over the surface to prevent the formation of a glossy surface. These blocks were on the average 8 inches thick, the other dimensions ranging from 10 in. by 30 in. to 18 in. by 36 in. They have weathered the elements very satisfactorily for five years. Some of the blocks have hair-checked somewhat, probably on account of having been troweled too much. By using the newly invented cork-faced trowel in place of the ordinary steel-bladed trowel, a rougher finish can be obtained. This finish no doubt will offer greater resistance to hair checking than will the smooth finish.

FIG. 19 BRUSHED

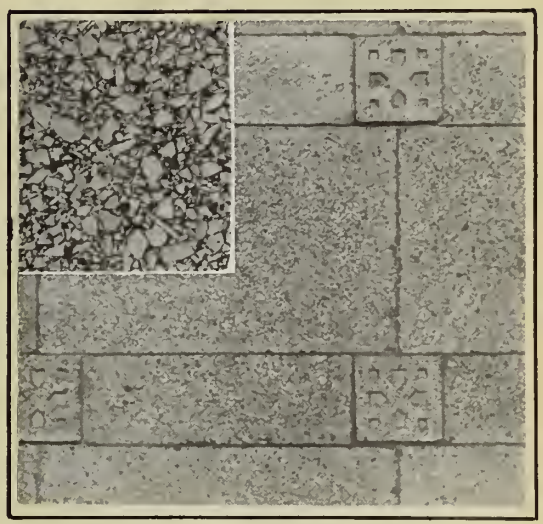


FIG. 20 RUBBED

FIG. 21 BUSH HAMMERED

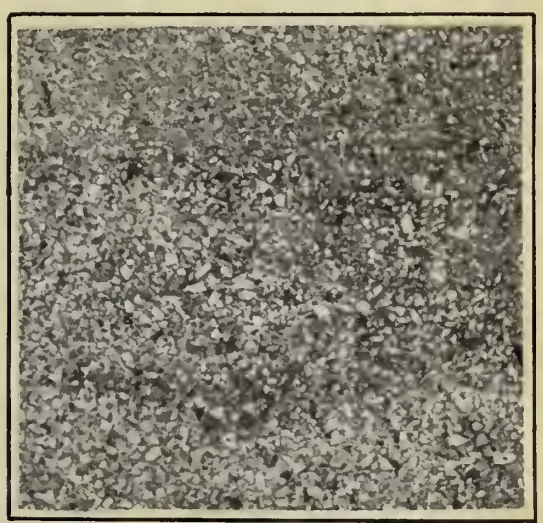


FIG. 22 SAND BLASTED

B. Rubbing and Grinding. Rubbing and grinding may be done either by hand or by machinery. In either case the rough surface of the newly-cast blocks is smoothed so that the larger aggregate will be polished and thus contrast against the matt suface of the cement matrix. The resulting surface may be likened to that of the ordinary terrazzo floor. (See Fig. 20).

The grinding materials are generally, sand, sandstone, soft brick, or carborundum, with water used as a lubricant. In hand rubbing, the sandstone, brick, or carborundum is placed in a long-handled holder which is held against the knee while standing and is drawn back and forth by swaying the whole body. This makes it less tiring than if the arms alone were used for the purpose. In machine rubbing, the block is placed on a rotating rubbing bed, sand or sandstone being the abrading material; or a portable power-grinding machine may be used.

It is well to note that by the rubbing process all the pores are filled up with cementitious particles. Recent experiments conducted by the German government show that this is one of the best ways in which to secure an impervious surface. Hence rubbed concrete blocks have the added advantage of being damp-proof. In conclusion it may be said that up to the present time the use of blocks with rubbed surfaces has been confined almost entirely to interiors, the rougher finishes being preferable for exteriors.

C. Scrubbing. Scrubbing is done by means of a wire- or a stiff-fibre brush. "A brush about four inches wide made by clamping together a sufficient number of sheets of wire cloth has been found to be more effective than the ordinary wire brush." Such a

brush is used (1) to remove the laitance or film of cement from the surface in order to prevent checking, or (2) for the purpose of removing the surface cement in order to expose the aggregate. (See Fig. 19). Concrete cast in sand molds or surfaces which have been troweled should be scrubbed whenever possible.

If the concrete is green, the brush may be used without water. If the block has set a day or so, water will be necessary; and if the block is set hard, 1 to 5 dilute muriatic acid will be indispensable. In general, if it is desired to bring the aggregate out sharply, acid is recommended; but it must be used with care on the greener blocks. After undergoing the acid treatment the blocks should be thoroughly rinsed with water to remove all traces of the acid.

Differentiation in light and shade can be secured by different degrees of scrubbing, as the more the surface is so scrubbed, the rougher it becomes. For the same reason it takes considerable practice to secure uniform results from scrubbing, as unless blocks are scrubbed alike they will not look alike.

Fig. 8 to 13 inclusive show surfaces which have been scrubbed.

D. Tooling. Faces which in many respects are the most beautiful that can be obtained with concrete, are secured by means of tooling, because by this means the beauty of the various constituents which go to make up this synthetic material are shown to best advantage.

The surface to be tooled should be hard set, as otherwise the finish will be uneven; and as the different materials offer varying resistance, it is essential that the facing mixture consist

of aggregate of uniform size and distribution.

The tools used are the same as those used on ordinary cut-stone, namely, the stone-axe, the chisel, and the bush-hammer. The first of these is particularly effective when used on green blocks; but the surface produced is very rough. For most tooling, the bush-hammer operated either by hand or by power is used. In this case in order that a true, smooth, bush-hammered surface be obtained, the concrete should be at least a month old. The size and number of points used on the hammers is optional. Hammers having anywhere from four to thirty-six pyramidal points are used, although the hammers with the fewer points seem to give the greatest satisfaction. Fig. 21 illustrates a bush-hammered surface. A somewhat different surface can be obtained by using a stone-axe or bush-hammer, and striking the surface with glancing blows, or by chiselling the surface, the direction of the chiselling being varied from time to time to give the surface a scored appearance. The latter method has been used on large buildings in Germany with excellent effect.

E. Sand Blasting The work of removing the surface cement by scrubbing is a laborious and costly process, if the cement has been given time enough to set hard. By using a sand blast against the concrete surface, substantially the same results can be obtained more quickly and more economically. See Fig. 22.

The nozzles used for sand blasting range in diameter from 1/8-inch to 3/8-inch, "depending upon the power in the compressor, the range and the size of the blasting aggregate". A clean, sharp, thoroughly dried silica sand or crushed quartz is most effective, and for use with a 1/4-inch nozzle the sand should be screened

through a No. 8 screen, and for a 1/8-inch nozzle through a No. 12 screen. The nozzle pressure required varies with the age of the concrete, a pressure of 60 pounds being sufficient for thirty-day old concrete, while older concrete may require as much as 80 pounds pressure.

If the blocks are sand-blasted before being placed in the wall, their edges should be inclosed in a bottomless box in order that the sand will be confined to the face of the block, and will not run over, and round off the edges. If the sand blast is used on a finished block-wall, all the joints should be well pointed up flush with the face of the wall a few days before using the sand blast. All arrises on water-table and projecting courses should be well protected by heavy paper or wood strips, as otherwise the sharp edges are very apt to be rounded off.

Conclusion. This completes the subject of mechanical treatment. In general, mechanical treatment is the cheapest and most satisfactory method of obtaining distinctive concrete surfaces; and in this field lies, very probably, the greatest future development in surface finish.

7. USE OF SURFACE COATINGS. The surface coatings to be discussed in this and the following paragraphs, are, in general, only those thin veneers used as coverings for finished surfaces in order to secure different color effects; or those used as a protective covering for the purpose of obliterating defects either in individual blocks or in a finished wall.

Surface coatings are applied in few, if any instances, to individual blocks, this process of treatment being confined almost entirely to walls. The coatings are applied to cover up poor

workmanship in walls built of dry-mixed, and checked blocks, and of blocks in which the cement has been skimped. Such blocks are frequently very absorptive and damp, and the coating is applied either to prevent the recurrence of the blotchy appearance or to cover it up entirely.

Many preparations now on the market claim to be effective in producing waterproof surfaces of all colors. Advertising literature contains pictures of many houses whose appearance has been improved decidedly by the use of these surface paints. The coatings look substantial, and no doubt the colors have lasting qualities which are comparable to those of stucco.

Surface coatings both transparent and colored are used. The transparent coatings are used to make the blocks impermeable and also damp-proof. With these coatings the color of the face, and in some cases the texture of the surface remain unchanged after their application. The formulas for these coatings are more or less secret, but the well-known Sylvester or soap-and-alum process, and the paraffine process, produce results similar to those claimed for these coatings, and possess the additional advantage of being preparable by the block manufacturer himself. The reader is referred to Baker's "Masonry Construction" and to Lewis' "Popular Handbook for Cement and Concrete Users" for the details governing the preparation and application of the Sylvester and the other processes.

A colorless damp-proofing solution, not so well known as those mentioned above, is one, recommended by Albert Moyer, composed of 1 part sodium silicate (water glass) and 4 to 6 parts of water, the exact amount of water depending on the porosity of the concrete. This solution is applied with a brush at intervals of 4 to 24 hours,

until the surface has been given three or four coats. The silicate combines with the alkalies in the cement and forms an insoluble substance.

Some of the colored surface coatings now on the market give good results, and appear worthy of consideration. In connection with the general subject of surface coatings, a recent report of a committee of the American Society of Testing Materials says: "While many penetration washes are efficient in rendering concrete waterproof for limited periods, their efficiency is apt to decrease with time, and it may be necessary to repeat such treatment. The committee therefore believes that the first effort should be made to secure a concrete that is impermeable in itself, and that penetration void-filling washes should only be resorted to as a corrective measure. The committee would point out that no addition of waterproofing compounds or substances can be relied upon to completely counteract the effect of bad workmanship." *

For additional discussion on porosity, etc., the reader is referred to Art. 1, Consistency.

In conclusion it may be stated that the best way to obtain colored concrete surfaces is to use colored aggregate. If these are not obtainable color obtained by using coloring pigment incorporated with the sand and cement in the facing material is preferable to that obtained by the use of surface coatings.

CONCLUSIONS CONCERNING THE ESTHETIC TREATMENT OF CONCRETE BLOCKS. As has been shown, the subject of the artistic treatment of the faces of the blocks comprises an extensive variety of details. A wide-spread knowledge of these details is essential for the up-

*Engineering-Contracting, Vol. 40, No. 3.

building of the concrete-block manufacturing business. Hence the articles on this and kindred subjects appearing in numerous cement magazines from time to time, offer encouraging evidence that the self-satisfied apathy of block manufacturers is being aroused, and that we may now look forward to seeing concrete blocks accorded much more general adoption.

CHAPTER II. ARCHITECTURAL TREATMENT OF BLOCK STRUCTURES.

INTRODUCTION. Architectural technique will not be considered in this chapter. The discussion will treat of the application of concrete blocks to various types of structures. To facilitate discussion the subject will be divided into three parts, viz: (1) concrete blocks for stucco work; (2) concrete blocks for base courses and trimmings; (3) concrete-block buildings.

ART. 1. CONCRETE BLOCKS FOR STUCCO WORK.

Concrete blocks are used for stucco-covered walls in the same way that hollow clay tile is used. (See Figs. 22A and 22B). No facing is put on these blocks which are left rough so as to afford a good bonding surface to which the stucco can adhere. Hence a cheap, coarse, mixture can be used throughout the blocks.

A type of block which might properly be called a concrete tile has recently appeared on the market. This block resembles clay tile in everything but color, and is made under pressure, of a dense, wet mixture. For stucco-finished work both concrete tile and concrete blocks are preferable to clay products because the former have a coefficient of expansion more nearly like that of stucco, and hence there are fewer chances for the formation of expansion cracks, and the stucco will adhere more closely to the blocks.

For large expanses of walls which are not required to withstand transverse bending, unit construction as typified by concrete blocks is preferable to solid concrete work, because while the individual blocks can readily accommodate themselves to temperature changes, the solid walls must be provided either with

PLATE VI STUCCO FINISH

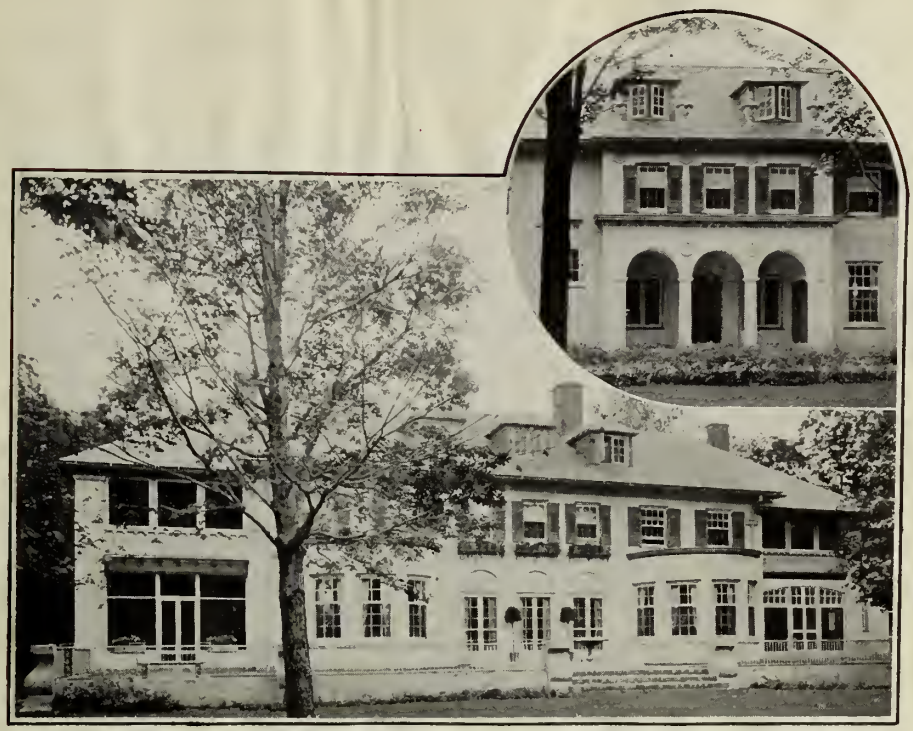


FIG. 22 A. RESIDENCE. STUCCO ON CONCRETE BLOCKS

FIG. 22 B. RESIDENCE. STUCCO ON CLAY TILE

numerous expansion joints which are more or less dependable as (many unsightly cracks testify) or with large quantities of steel temperature reinforcement.

Fig. 22B shows a residence on which there is comparatively little ornamentation, and on which, consequently, standard sized blocks made on ordinary molding machines could be economically used for the greater part of the structure.

ART. 2. CONCRETE BLOCKS FOR BASE-COURSES AND TRIMMING.

For the larger or monumental structures, stone has generally been given precedence over brick. The very nature of these materials has been the foundation for this discrimination, for stone is a natural and massive product, while brick is an artificial and comparatively diminutive product. This distinction has been carried over into the design of smaller buildings such as residences and apartment houses where the stone has been used for foundations and lintels, etc., to lend massiveness to brick structures. Furthermore the beautiful color contrasts shown in structures in which both stone and brick have been used, have made the combined use of these two materials very desirable. Of late years, however, trim stone has been displaced for economic reasons by the relatively cheaper face-brick. Such brick may be procured in a variety of colors so that color contrasts are easily obtained.

The development in the art of the manufacture of concrete blocks warrants a prediction that blocks will, sometime in the future, supplant brick for trim work. Fig. 23 and 24 show two buildings, part of a large estate on which more than one million concrete blocks were used.

FIG. 23

FIG. 24

CONCRETE-BLOCK BASE COURSE AND TRIM

FIG. 25 CONC. BLOCK BASE COURSE

FIG. 26

FIG. 27

PLAIN FACE VS. ROCK-FACE BLOCKS

Concrete blocks are cast stone, and if made properly can lend the peculiar attributes of stone -- massiveness and stability - to the structure into which they are built. Furthermore, the architect can specify all kinds of ornamental concrete work with the assurance that the product will fully express the designers ideas. With a little practice the manufacturer can turn out first class under-cut molded work which is made by pouring very wet concrete into sand- or glue-molds. Sometimes the poured work is tooled to give it a more pleasing texture. See also Fig. 39.

Directions for making patterns and molds can be found in "Concrete From Sand Molds" by A. A. Houghton, and in " The Manufacture of Concrete Blocks and Their Use in Building Construction." bt Rice and Torrance, et al.

By using various combinations of colored aggregate for the facing materials, excellent color contrasts can be obtained when the blocks are used as trim for tapestry- and other face-brick.

Fig. 25 shows buildings in which dark red brick was set off by the concrete blocks used for the base courses.

ART. 3. CONCRETE-BLOCK BUILDINGS.

Concrete-block buildings will be divided for convenience of discussion into three classes: (1) residences and apartment buildings; (2) office buildings, factories, etc.; (3) school houses and monumental structures.

1. RESIDENCES AND APARTMENT BUILDINGS. The use of concrete blocks for dwellings is advisable for two reasons. In the first place, if some form of hollow wall construction is used, a more uniform temperature is maintained throughout the day and during

FIG. 28 CONCRETE-BLOCK RESIDENCE
WHITE CARTHAGE LIMESTONE CHIPS USED FOR AGGREGATE

FIG. 29 CONCRETE-BLOCK RESIDENCE
BLACK GRANITE-COMMON CEMENT, BELOW SILL;
BLACK GRANITE-WHITE CEMENT, ABOVE SILL.

the different seasons of the year. This is because both the dead air space and the concrete itself are very poor conductors of heat. Hence the intense heat of mid-summer afternoon begins to cool off with the sinking sun before the heat has had time to penetrate to the interior of the building, while in winter time the fuel bill is lessened because the heat used to maintain a comfortable warmth is not readily dissipated through the walls of the building to the great out-of-doors. In the second place, tests have shown that concrete is the best fire-resisting material, and hence there is the element of fire-protection which is of considerable importance to the owners of dwellings.

Concrete-block residences are illustrated in Fig. 26 to 29, and the relative effect of plain-face and rock-face block buildings is shown in Fig. 26 and 27. The photograph is charitable to the rock-face block.

2. OFFICE BUILDINGS, FACTORIES, ETC. Many existing structures testify by their ugliness to the strictly utilitarian principles governing their design. When concrete blocks first came into prominence it was thought that still greater economy could be effected by their use. So the cheap, dry-mixed, rock-faced concrete blocks were built into factories, grain elevators, garages and what not. Two of these structures are shown in Fig. 32 and 33.

The large part played by comfort and esthetic influence in promoting the efficiency of the employee has been made much of within the past few years, and present-day factories and other places of employment are being constructed with these facts in view. Floors are now constructed of reinforced concrete and the old type

PLATE IX PLAIN-AND ROCK-FACE BUILDINGS

FIG.30 FACTORY OFFICE BUILDING. PLAIN-FACED BLOCKS

FIG.31 FACTORY. PLAIN-FACED BLOCKS

FIG.32 ELEVATOR. ROCK-FACE

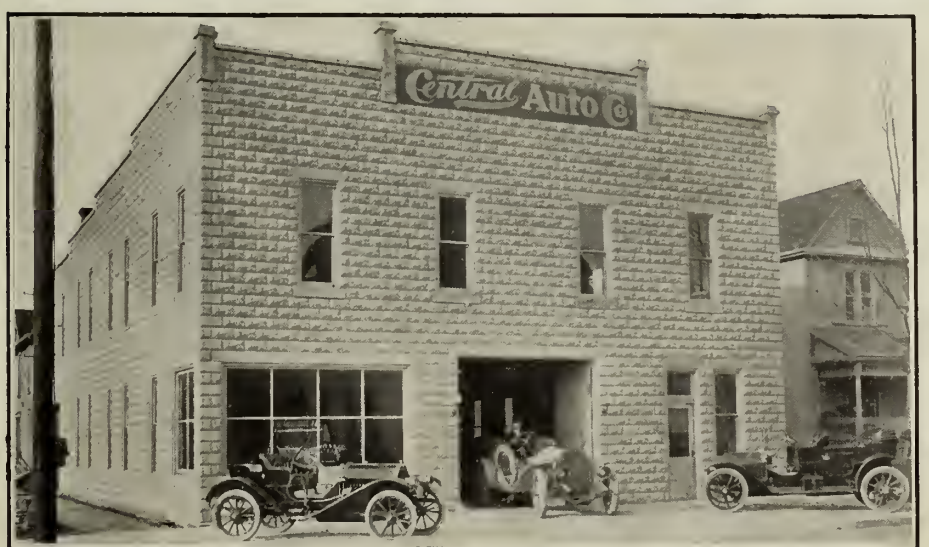


FIG.33 GARAGE ROCK-FACED BLOCKS

of plain, barn-like walls have been superseded by walls built of brick trimmed with stone or terra cotta. Blocks are recommended in place of either stone or terra cotta on the ground of greater economy.

Fig. 30 and 31 show factory buildings constructed of concrete blocks.

3. SCHOOL HOUSES AND MONUMENTAL STRUCTURES. It is in the field of larger structure that the concrete block has been accorded greatest opposition. The design of large structures such as churches, school buildings, legislative buildings, museums, etc., is entrusted to architects having relatively greater reputation than those who design residences, etc. Few of the former have dared to risk their reputation by using concrete blocks. From an architectural point of view, rock-face blocks are an abomination, and although architects by conscientiously experimenting with various kinds of blocks could have paved the way for the proper manufacture of blocks, they have been loth to do so. Nevertheless, some large concrete-block structures have been built. See Fig. 34 to 40.

As has already been suggested, concrete blocks may well be substituted for cut stone and terra cotta in buildings of a monumental character, in which the ornamentation is simple. Developments in sand- and glue-molded concrete ornamentation have as yet not been such as to warrant a materially reduced cost as compared with the cost of cut stone or terra cotta masonry, but in any case the great amount which may be saved in the straight-away work will provide a substantial reduction in the total cost of the masonry.

The Normal Park Church, Chicago, illustrated in Fig. 34 to 36 is a beautiful piece of work. The walls were constructed of concrete blocks backed up with brick at a saving of $6,000 over the

PLATE X CONCRETE-BLOCK CHURCH

FIG. 34 CHURCH. COLORED AGGREGATE

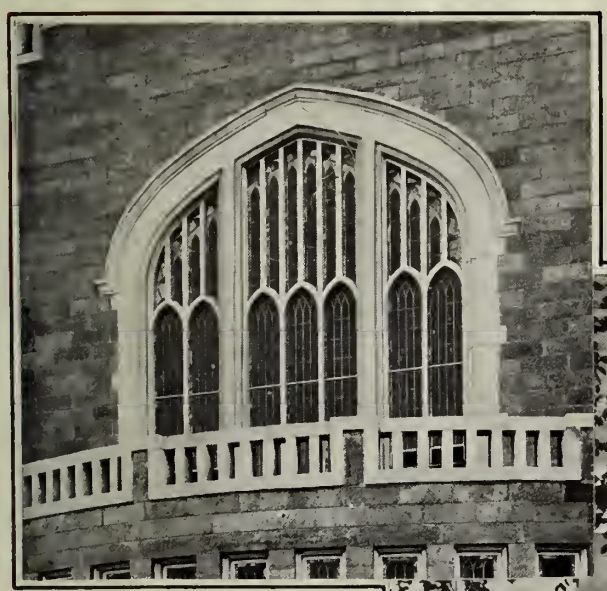


FIG. 35 CAST-STONE WINDOW TRIM

FIG. 36 ENTRANCE

cost of granite, and at a saving of about 10 per cent over the cost in brick and stone masonry. The trim and belt courses were made of white blocks faced with white cement and white sand, and the walls were made of blocks faced with dark granite chips and ordinary Portland cement. There is a slight variation in color from block to block which affords a pleasing break in the monotony of color. The tracery around the windows was cast in wood molds, but by careful manipulation the same color and texture was obtained as in the machine-made blocks.

Fig. 37 illustrates a large mansion.

The Nebraska State Normal School Building shown in Fig. 38 is of monumental type of construction. The walls had not been pointed up at the time the picture was taken.

The Chicago Sanitary District Power House shown in Fig. 40, and costing $292,000 was built throughout of concrete blocks. The details shown in Fig. 39 were cast in sand molds.

FIG. 37 COUNTRY ESTATE

FIG. 38 NORMAL SCHOOL BUILDING

FIG.39 ORNAMENT CAST IN SAND MOLDS FOR USE ON POWER HOUSE

FIG. 40 CONCRETE-BLOCK POWER HOUSE

GENERAL CONCLUSIONS.

In the majority of buildings in which blocks were used, the plain- or panel-faced variety of blocks were shown to be decidedly preferable to the rock-faced blocks; and therein lies the hope for ultimate recognition of concrete blocks. It is often claimed that blocks are unconditionally cheaper than cut-stone, terra cotta, or brick. This statement is not strictly true, as the relative cost depends a great deal upon the location of the structure. Unfortunately, the cost of concrete blocks can always be cut a little to meet competition, without the blocks showing an appreciable difference in appearance. But the cost of maintenance will eat up the money saved at the beginning, and the ultimate result will be a cheap looking building. Details of manufacture are not within the scope of this thesis, but enough concerning the ultimate purpose of concrete blocks has been described to show wherein improvements in manufacture might be instituted. Finally, the pictures of concrete-block buildings already built offer encouragement for the realization of the ultimate success in a large way, of the concrete-block industry.

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